PATENT ABSTRACTS OF JAPAN

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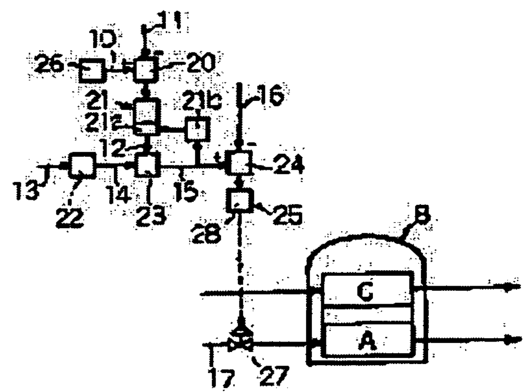
(54) FLOW CONTROL METHOD AND DEVICE AT FUEL CELL START

(57)Abstract:
PURPOSE: To perform preset load operation without increasing a fuel utilization factor at the time of a start, start a fuel cell, generate power, and heat it to the operating temperature in a short time by increasing the anode gas flow when the fuel utilization factor becomes too high.



CONSTITUTION: A fuel utilization factor 11 during operation is calculated from the anode gas flow when a fuel cell 8 is started. If the utilization factor 11 is higher than the preset maximum fuel utilization factor 10, the utilization factor 11 during operation is subtracted from the utilization factor 10 by a first subtracter 20, and a flow signal 12 to make the result positive is set by a first gas quantity setter 21. An anode gas flow is controlled to approximate the subtraction result by a subtracter 24 to zero by a gas quantity controller 25 via a second gas quantity setter 22, a high-signal selector 23, and the second subtracter 24. The anode gas flow can be increased to reduce the utilization factor 11 to the utilization factor 10, a large quantity of the anode gas is fed, the cell output is increased, a large quantity of reaction heat is generated, and the fuel cell 8 can be heated to the preset operating temperature in a short time.

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CLAIMS

[Claim(s)]
[Claim 1] The control-of-flow approach at the time of fuel cell starting characterized by what an anode gas flow rate, an anode gas presentation, and the current of a fuel cell are measured, a fuel utilization rate is computed from said anode gas flow rate, an anode gas presentation, and the current of a fuel cell, an anode gas flow rate is increased when said fuel utilization rate is higher than the predetermined maximum fuel utilization rate, and said fuel utilization rate is lowered for to the maximum fuel utilization rate at the time of starting of a fuel cell.
[Claim 2] The 1st subtractor which subtracts the fuel utilization rate signal under operation from the maximum fuel utilization rate signal, The 1st capacity setter which sets up the flow rate signal for just carrying out it when the subtraction result by this 1st subtractor is negative, The 2nd capacity setter which sets up a required flow rate signal based on a load command, The high signal selector which compares the flow rate signal set up by said 1st capacity setter and 2nd capacity setter, and chooses the flow rate signal of the larger one, the subtraction result by the 2nd subtractor which subtracts the flow rate signal of the anode gas flow rate under operation from the flow rate signal by this high signal selector, and this 2nd subtractor -- zero -- ******** -- the flow rate control unit at the time of fuel cell starting characterized by having the capacity controller which controls an anode gas flow rate like.
[Claim 3] Said capacity controller is a flow rate control unit at the time of fuel cell starting according to claim 2 characterized by what is consisted of a flow control valve prepared in the anode gas line, and a controller which controls this flow control valve.
[Claim 4] Said 1st capacity setter is a flow rate control unit at the time of fuel cell starting according to claim 2 characterized by what it has further for the minimum setter which sets up a flow rate signal so that an anode gas flow rate may not become below a predetermined minimum.
[Claim 5] Said 1st capacity setter and a capacity controller are a flow rate control unit at the time of fuel cell starting according to claim 2 characterized by the thing which performs proportional control and integral control, and which it is a PI control machine.
[Claim 6] Said 2nd capacity setter is a flow rate control unit at the time of fuel cell starting according to claim 2 characterized by the thing which sets up a required flow rate signal with a predetermined function based on a load command, and which it is a function controller.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the control-of-flow approach of the anode gas at the time of starting of a fused carbonate fuel cell, and equipment in more detail with respect to the control approach of a fuel cell power plant, and equipment.
[0002]
[Description of the Prior Art] That a fused carbonate fuel cell has little effect on efficient and an environment etc. has the description it is featureless to the conventional power plant, attention is attracted as a generation-of-electrical-energy system following hydraulic power, thermal power, and atomic energy, and researches and developments are wholeheartedly done in current every country in the world. It is in the limelight as a system which can reduce the loss accompanying the conventional power transmission sharply, and can demonstrate 80% or more of thermal efficiency by distributing and installing the fuel cell of the melting carbonate mold equipped with especially the reforming machine in a building, an apartment, etc. of the city section, and performing a generation of electrical energy and an air conditioning by using town gas as a fuel.
[0003] It has a reforming machine and a fuel cell, and this power plant reforms fuel gas to the anode gas containing hydrogen with a reforming vessel, it generates the electrical and electric equipment with a fuel cell from this anode gas and the cathode gas containing oxygen, and manufactures warm water with that remaining heat. The main cell reactions within this fuel cell are H2+CO3 2-->H2 O+CO2+2e. An anode reaction and 1/2 O2+CO2+2e ->CO3 2- It is a cathode reaction and hydrogen (H2) is the reaction which changes to water (H2 O) as the whole. Therefore, exhaust gas of a fuel cell power plant is essentially clean, and there is very little effect on an environment.
[0004]
[Problem(s) to be Solved by the Invention] A fused carbonate fuel cell can make the hydrogen which is a fuel react 80% or more by the anode reaction mentioned above theoretically. However, practical, since diffusion of the gas within a fuel cell was not perfect, when it operated by the high fuel utilization rate (for example, 80% or more), the active zone which runs short of fuels partially was made, and there was a trouble of damaging the electrode of a fuel cell from this part.
[0005] On the other hand, since a fuel cell power plant is distributed and installed in the city section, to make it start for a short time by the demand by the side of a load, and to generate electricity is demanded. For this reason, before the fuel cell had carried out the temperature up completely at the time of starting, the generation of electrical energy was started having covered the load, and the means to which the temperature up of the fuel cell is carried out to a predetermined operating temperature with the heat of reaction by generation of electrical energy was used from the former after that. The flow rate control unit at the time of this conventional fuel cell starting For example, the capacity setter 3 which sets up the required flow rate signal 2 based on the load command 1 as shown in drawing 3 , The subtractor 5 which subtracts the flow rate signal 4 under operation from the flow rate signal 2 set up by this capacity setter, It has the capacity controller 6 which controls an anode gas flow rate like. the subtraction result by this subtractor 5 -- zero -- ******** -- The anode gas flow rate which flows from a reforming machine (not shown) to a fuel cell 8 at the time of starting of a fuel cell was measured, and the flow control valve 9 was controlled to become the anode gas flow rate to which this anode gas flow rate was set by the capacity setter 3.

[0006] However, in this conventional control means, when the current was taken out having covered the load in the phase as for which cell temperature has carried out the temperature up, in spite of having not reached rated output, the fuel utilization rate became high too much, and there was a trouble that there was a possibility of damaging the electrode of about [that predetermined load operation cannot be performed] or a fuel cell.
[0007] This invention is originated in order to solve this trouble. That is, the purpose of this invention can perform predetermined load operation, without raising a fuel utilization rate at the time of starting of a fuel cell, and is to offer the control-of-flow approach at the time of fuel cell starting which can be started and generated in a short time, and equipment. Furthermore, the purpose of this invention is to offer the control-of-flow approach at the time of fuel cell starting which can carry out the temperature up of the fuel cell to a short time after starting to an operating temperature, and equipment.
[0008]
[Means for Solving the Problem] According to this invention, the control-of-flow approach at the time of fuel cell starting characterized by what an anode gas flow rate, an anode gas presentation, and the current of a fuel cell are measured, a fuel utilization rate is computed from said anode gas flow rate, an anode gas presentation, and the current of a fuel cell, an anode gas flow rate is increased and said fuel utilization rate is lowered for to the maximum fuel utilization rate at the time of starting of a fuel cell when said fuel utilization rate is higher than the predetermined maximum fuel utilization rate is offered.
[0009] Furthermore, the 1st subtractor which subtracts the fuel utilization rate under operation from the maximum fuel utilization rate according to this invention, The 1st capacity setter which sets up the flow rate signal for just carrying out it when the subtraction result by this 1st subtractor is negative, The 2nd capacity setter which sets up a required flow rate signal based on a load command, The high signal selector which compares the flow rate signal set up by said 1st capacity setter and 2nd capacity setter, and chooses the flow rate signal of the larger one, The 2nd subtractor which subtracts the flow rate signal of the anode gas flow rate under operation from the flow rate signal by this high signal selector, the subtraction result by this 2nd subtractor -- zero -- ******** -- the flow rate control unit at the time of fuel cell starting characterized by having the capacity controller which controls an anode gas flow rate like is offered.
[0010] According to the desirable example of this invention, said capacity controller consists of a flow control valve prepared in the anode gas line, and a controller which controls this flow control valve. Moreover, said 1st capacity setter is further equipped with the minimum setter which sets up a flow rate signal so that an anode gas flow rate may not become below a predetermined minimum. Furthermore, said 1st capacity setter and a capacity controller are PI control machines which perform proportional control and integral control. Moreover, as for said 2nd capacity setter, it is good that it is the function controller which sets up a required flow rate signal with a predetermined function based on a load command.
[0011]
[Function] The cause by which a fuel utilization rate becomes high too much with the conventional starting means in spite of having not reached rated output at the time of starting Since the temperature of a fuel cell is low, if the electrical potential difference of a fuel cell is low and it is going to obtain a predetermined cell output **** with a low electrical potential difference -- it is necessary to take out a large current (output = electrical-potential-difference x current), the above-mentioned anode reaction will be advanced to the right as a result, a lot of hydrogen was exhausted, and it turned out that it is because a fuel utilization rate becomes high.
[0012] This invention lowers a fuel utilization rate by increasing an anode gas flow rate, without controlling an anode reaction, when a fuel utilization rate becomes high too much based on the starting new knowledge. According to this invention, at the time of starting of a fuel cell Namely, an anode gas flow rate, An anode gas presentation and the current of a fuel cell are measured. Said anode gas flow rate, By computing a fuel utilization rate from an anode gas presentation and the current of a fuel cell, increasing an anode gas flow rate, when said fuel utilization rate is higher than the predetermined maximum fuel utilization rate, and lowering said fuel utilization rate to the maximum fuel utilization rate a fuel cell -- anode gas -- extensive -- supplying -- **** with a low

electrical potential difference -- it can make it possible to take out a large current, a cell output can be heightened and combined, and a fuel utilization rate can be lowered. Furthermore, according to the approach of this this invention, an anode reaction is performed positively, without lowering a fuel utilization rate, as a result, heat of reaction occurs so much by the anode reaction, and the temperature up of the fuel cell can be carried out in a short time to an operating temperature with this heat of reaction.
[0013]
[Example] The desirable example of this invention is explained with reference to a drawing below. Drawing 1 is drawing showing the starting performance of the fuel cell by the conventional control-of-flow approach. In this drawing, an axis of abscissa t is the elapsed time after starting (Hr), in T of an axis of ordinate, the temperature (degree C) of a fuel cell and V show the electrical potential difference (mmV) of a fuel cell (single cel), and Uf shows the fuel utilization rate (%).
[0014] At the time of starting, the temperature T of a fuel cell is low, for example, it is about 600 degrees C in 4 hours after starting, and amounts to about 700 degrees C of plan temperature in about 8 hours after starting so that clearly from this drawing. Moreover, at the time of starting, the electrical potential difference V of a fuel cell is low, about 8 hours passed after starting too, and the fixed value (about 830mV) is reached. The thing with a low electrical potential difference is because temperature is low at the time of starting. therefore -- if it is going to obtain a cell output predetermined in this phase -- **** with a low electrical potential difference -- it is necessary to take out a large current (output = electrical-potential-difference x current), the anode reaction mentioned above as a result will be advanced to the right, a lot of hydrogen is exhausted, and a fuel utilization rate becomes high. In drawing 1 , the fuel utilization rate Uf at the time of starting is high, and is considered that especially becoming 80% or more in early stages is based on this cause.
[0015] Drawing 2 is the whole block diagram showing the flow rate control unit at the time of fuel cell starting of this invention based on the starting new knowledge. In drawing 2 the flow rate control unit at the time of fuel cell starting of this invention The 1st subtractor 20 which subtracts the fuel utilization rate 11 under operation from the maximum fuel utilization rate 10, The 1st capacity setter 21 which sets up the flow rate signal 12 for just carrying out it when the subtraction result by this 1st subtractor 20 is negative, The 2nd capacity setter 22 which sets up the required flow rate signal 14 based on the load command 13, The high signal selector 23 which compares the flow rate signals 12 and 14 set up by the 1st capacity setter 21 and the 2nd capacity setter 22, and chooses the flow rate signal (the time of starting 12) of the larger one, the subtraction result by the 2nd subtractor 24 which subtracts the flow rate signal 16 of the anode gas flow rate under operation from the flow rate signal 15 by this high signal selector 23, and this 2nd subtractor 24 -- zero -- ******** -- it has the capacity controller 25 which controls an anode gas flow rate like. The maximum fuel utilization rate 10 is set up by the maximum utilization factor setter 26. Moreover, the load command 13 is separately set up by the control unit (not shown) of the whole fuel cell power plant. In addition, the signal between each control equipment mentioned above is an electrical signal.
[0016] The capacity controller 25 consists of a flow control valve 27 prepared in the anode gas line 17, and a controller 28 which controls this flow control valve 27. As for this flow control valve 27, it is desirable that it is a pneumatics control valve. Thereby, the flow control valve 27 of a large flow rate is easily controllable. The 1st capacity setter 21 is further equipped with minimum setter 21a so that the flow rate signal 12 set up may not become below a predetermined minimum. This minimum setter 21a feeds back the flow rate signal 15 by the high signal selector 23 through bias set station 21b, and sets up the minimum of the flow rate signal 12 slightly lower than the flow rate signal 15. It can prevent an anode gas flow rate's becoming low too much, and a fuel utilization rate becoming high unusually by this.
[0017] As for the 1st capacity setter 21 and the capacity controller 25, it is good that it is the PI control machine which performs proportional control (P-action) and integral control (integral action). By this, as long as there is deflection, a control input is changed, and it is stabilized in the place whose deflection was lost, and a controlled variable can always be maintained near the target. As for the 2nd capacity setter 22, it is good that it is the function controller which sets up a required flow rate signal with a predetermined function (F (X)) based on a load command. Thereby, it is F (X) beforehand about a function peculiar to a fuel cell. By setting up by carrying out, the required flow

rate signal 14 can be set up correctly.
[0018] According to the control-of-flow approach at the time of fuel cell starting of this invention, the control unit of the above-mentioned configuration operates as follows. First, the anode gas flow rate at the time of starting of a fuel cell, an anode gas presentation, and the current of a fuel cell are measured. This measurement is conventionally measurable using a well-known flowmeter, a concentration meter, and an ammeter. Subsequently, the fuel utilization rate 11 under operation is computed from the measured anode gas flow rate, an anode gas presentation, and the current of a fuel cell. When this fuel utilization rate 11 is higher than the predetermined maximum fuel utilization rate 10, the fuel utilization rate 11 under operation is subtracted from the maximum fuel utilization rate 10 with the 1st subtractor 20. The flow rate signal 12 for just carrying out this subtraction result (it becoming negative at the time of starting) is set up by the 1st capacity setter 21. Based on the load command 13, the required flow rate signal 14 is set up by the 2nd capacity setter 22. The high signal selector 23 compares the flow rate signals 12 and 14, and the flow rate signal (12) of the larger one is chosen. The flow rate signal 16 of the anode gas flow rate under operation is subtracted from the flow rate signal 15 by the high signal selector 23 with the 2nd subtractor 24. the subtraction result according to the 2nd subtractor 24 by the capacity controller 25 -- zero -- ******** -- by controlling an anode gas flow rate like, the actual anode gas flow rate which flows the anode gas line 17 is increased, and a fuel utilization rate 11 is lowered to the maximum fuel utilization rate 10. thereby -- a fuel cell -- anode gas -- extensive -- supplying -- **** with a low electrical potential difference -- it can become possible to take out a large current, it can heighten and combine a cell output as a result, and can lower a fuel utilization rate. Moreover, as a result of performing an anode reaction positively, without lowering a fuel utilization rate, heat of reaction occurs so much by the anode reaction, and the temperature up of the fuel cell can be carried out in a short time to a predetermined operating temperature with this heat of reaction.
[0019]
[Effect of the Invention] Therefore, according to the approach and equipment of this invention, predetermined load operation can be performed, without raising a fuel utilization rate at the time of starting of a fuel cell, and it can start and generate electricity in a short time, and the temperature up of the fuel cell can be collectively carried out to a short time after starting to an operating temperature.

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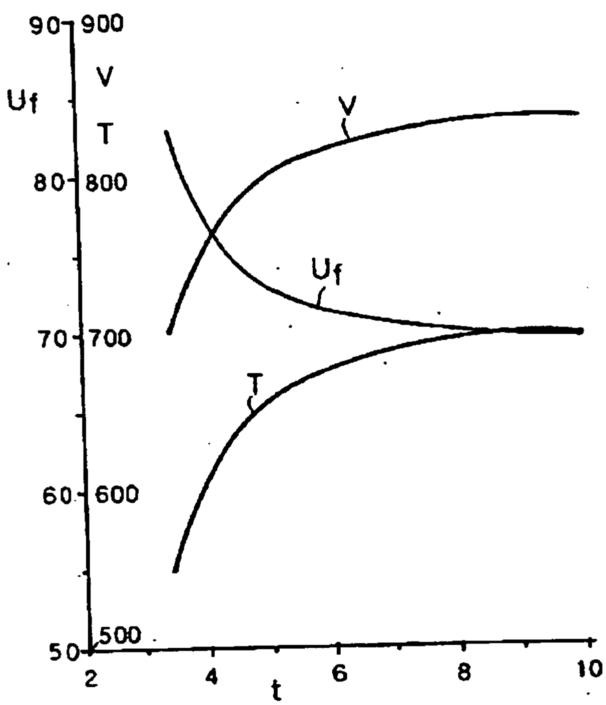
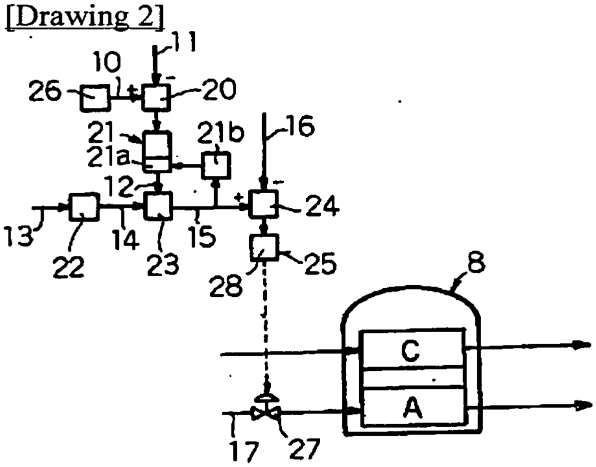
DRAWINGS

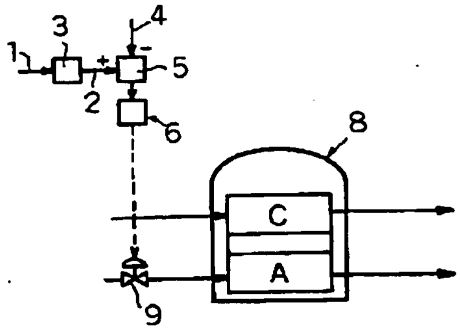
[Drawing 1]



[Drawing 2]



[Drawing 3]



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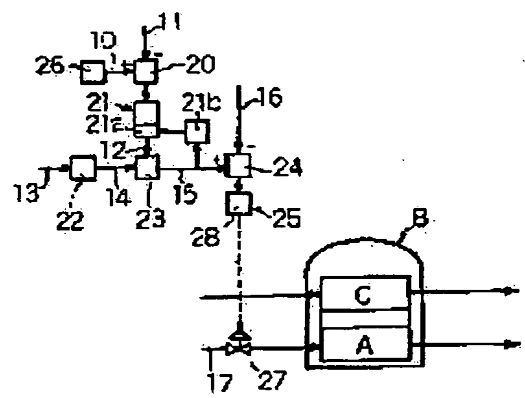
(54) FLOW CONTROL METHOD AND DEVICE AT FUEL CELL START

(57)Abstract:
PURPOSE: To perform preset load operation without increasing a fuel utilization factor at the time of a start, start a fuel cell, generate power, and heat it to the operating temperature in a short time by increasing the anode gas flow when the fuel utilization factor becomes too high.
CONSTITUTION: A fuel utilization factor 11 during operation is calculated from the anode gas flow when a fuel cell 8 is started. If the utilization factor 11 is higher than the preset maximum fuel utilization factor 10, the utilization factor 11 during operation is subtracted from the utilization factor 10 by a first subtracter 20, and a flow signal 12 to make the result positive is set by a first gas quantity setter 21. An anode gas flow is controlled to approximate the subtraction result by a subtracter 24 to zero by a gas quantity controller 25 via a second gas quantity setter 22, a high-signal selector 23, and the second subtracter 24. The anode gas flow can be increased to reduce the utilization factor 11 to the utilization factor 10, a large quantity of the anode gas is fed, the cell output is increased, a large quantity of reaction heat is generated, and the fuel cell 8 can be heated to the preset operating temperature in a short time.



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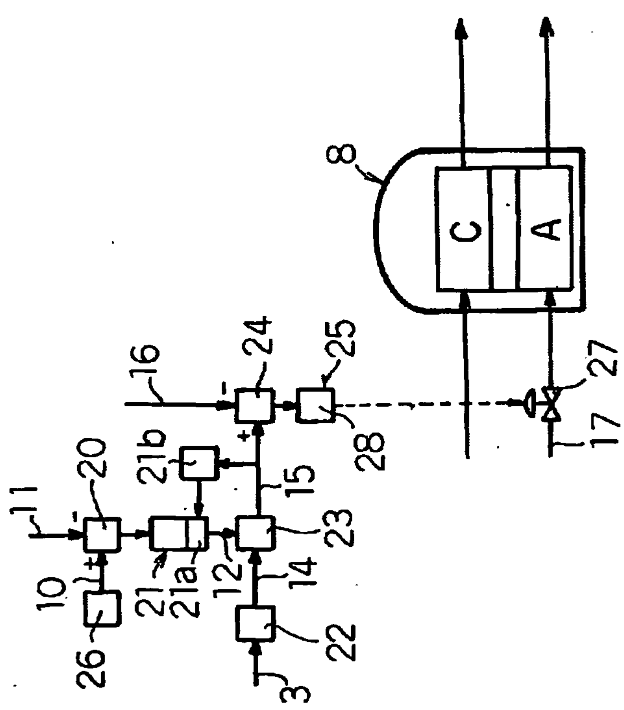
(54)【発明の名称】　燃料電池起動時の流量制御方法及び装置

(57)【要約】
【目的】　燃料電池の起動時に燃料利用率を高めることなく所定の負荷運転を行うことができ、かつ短時間に起動し発電することができ、起動後短時間に運転温度まで燃料電池を昇温できる燃料電池起動時の流量制御方法及び装置を提供する。
【構成】　燃料電池８の起動時に、アノードガス流量、アノードガス組成、及び燃料電池の電流を計測し、アノードガス流量、アノードガス組成、及び燃料電池の電流から燃料利用率１１を算出し、燃料利用率が所定の最大燃料利用率１０より高い場合に、アノードガス流量を増やして燃料利用率１１を最大燃料利用率１０まで下げる。



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【特許請求の範囲】

【請求項1】 燃料電池の起動時に、アノードガス流量、アノードガス組成、及び燃料電池の電流を計測し、前記アノードガス流量、アノードガス組成、及び燃料電池の電流から燃料利用率を算出し、
前記燃料利用率が所定の最大燃料利用率より高い場合に、アノードガス流量を増やして前記燃料利用率を最大燃料利用率まで下げる、ことを特徴とする燃料電池起動時の流量制御方法。

【請求項2】 最大燃料利用率信号から運転中の燃料利用率信号を減算する第1の減算器と、該第1減算器による減算結果が負の場合にそれを正にするための流量信号を設定する第1のガス量設定器と、負荷指令に基づき必要な流量信号を設定する第2のガス量設定器と、前記第1ガス量設定器と第2ガス量設定器により設定された流量信号を比較して大きい方の流量信号を選択する高信号選択器と、該高信号選択器による流量信号から運転中のアノードガス流量の流量信号を減算する第2の減算器と、該第2減算器による減算結果を零に近ずけるようにアノードガス流量を制御するガス量制御器と、を備えることを特徴とする燃料電池起動時の流量制御装置。

【請求項3】 前記ガス量制御器は、アノードガスラインに設けられた流量調節弁と、該流量調節弁を制御する調節器とからなる、ことを特徴とする請求項2に記載の燃料電池起動時の流量制御装置。

【請求項4】 前記第1ガス量設定器は、アノードガス流量が所定の下限以下にならないように流量信号を設定する下限設定器を更に備える、ことを特徴とする請求項2に記載の燃料電池起動時の流量制御装置。

【請求項5】 前記第1ガス量設定器及びガス量制御器は、比例制御及び積分制御を行うＰＩ制御器である、ことを特徴とする請求項2に記載の燃料電池起動時の流量制御装置。

【請求項6】 前記第2ガス量設定器は、負荷指令に基づき所定の関数により必要な流量信号を設定する関数制御器である、ことを特徴とする請求項2に記載の燃料電池起動時の流量制御装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、燃料電池発電装置の制御方法及び装置に係わり、更に詳しくは、溶融炭酸塩型燃料電池の起動時のアノードガスの流量制御方法及び装置に関する。

【０００２】

【従来の技術】溶融炭酸塩型燃料電池は、高効率、かつ環境への影響が少ないなど、従来の発電装置にはない特徴を有しており、水力・火力・原子力に続く発電システムとして注目を集め、現在世界各国で鋭意研究開発が行われている。特に改質器を備えた溶融炭酸塩型の燃料電池は、都市部のビルやマンション等に分散して設置し、都市ガスを燃料として発電と冷暖房を行うことにより、従来の送電に伴うロスを大幅に低減でき、かつ８０％以上の熱効率を発揮できるシステムとして脚光を浴びている。

【０００３】かかる発電装置は、改質器と燃料電池を備え、改質器により燃料ガスを水素を含むアノードガスに改質し、このアノードガスと酸素を含むカソードガスとから燃料電池により電気を発電し、その余熱により温水を製造するものである。この燃料電池内での主な電池反応は、

$H_2 + CO_3^{2-} \rightarrow H_2O + CO_2 + 2e$ のアノード反応と、

$1/2\ O_2 + CO_2 + 2e \rightarrow CO_3^{2-}$ のカソード反応であり、全体としては水素（H_2）が水（H_2O）に変わる反応である。従って、燃料電池発電装置は本質的に排ガスがクリーンであり、環境への影響が極めて少ない。

【０００４】

【発明が解決しようとする課題】溶融炭酸塩型燃料電池は原理的には上述したアノード反応により燃料である水素を８０％以上反応させることができる。しかし、実用的には、燃料電池内でのガスの拡散が完全ではないので、高い燃料利用率（例えば８０％以上）で運転すると部分的に燃料が不足する反応部分ができ、この部分から燃料電池の電極を損傷させてしまう問題点があった。

【０００５】一方、燃料電池発電装置は、都市部に分散して設置されるため、負荷側の要求により短時間に起動させ発電することが要望される。このため、起動時には燃料電池が完全に昇温しきる前に、負荷をかけて発電を開始し、その後、発電による反応熱で燃料電池を所定の運転温度まで昇温させる手段が従来から用いられていた。かかる従来の燃料電池起動時の流量制御装置は、例えば図３に示すように、負荷指令１に基づき必要な流量信号２を設定するガス量設定器３と、このガス量設定器により設定された流量信号２から運転中の流量信号４を減算する減算器５と、この減算器５による減算結果を零に近ずけるようにアノードガス流量を制御するガス量制御器６とを備え、燃料電池の起動時に、改質器（図示せず）から燃料電池８へ流れるアノードガス流量を計測し、このアノードガス流量がガス量設定器３により設定されたアノードガス流量になるように流量調節弁９が制御されていた。

【０００６】しかし、かかる従来の制御手段では電池温度が昇温しきっていない段階で負荷をかけて電流を取り出すと、定格出力に達していないにもかかわらず燃料利用率が高くなり過ぎ、所定負荷運転を行えないばかりか燃料電池の電極を損傷させるおそれがある問題点があった。

【０００７】本発明は、かかる問題点を解決するために創案されたものである。すなわち、本発明の目的は、燃

料電池の起動時に燃料利用率を高めることなく所定の負荷運転を行うことができ、かつ短時間に起動し発電することができる燃料電池起動時の流量制御方法及び装置を提供することにある。更に本発明の目的は、起動後短時間に運転温度まで燃料電池を昇温できる燃料電池起動時の流量制御方法及び装置を提供することにある。

【０００８】

【課題を解決するための手段】本発明によれば、燃料電池の起動時に、アノードガス流量、アノードガス組成、及び燃料電池の電流を計測し、前記アノードガス流量、アノードガス組成、及び燃料電池の電流から燃料利用率を算出し、前記燃料利用率が所定の最大燃料利用率より高い場合に、アノードガス流量を増やして前記燃料利用率を最大燃料利用率まで下げる、ことを特徴とする燃料電池起動時の流量制御方法が提供される。

【０００９】更に本発明によれば、最大燃料利用率から運転中の燃料利用率を減算する第１の減算器と、該第１減算器による減算結果が負の場合にそれを正にするための流量信号を設定する第１のガス量設定器と、負荷指令に基づき必要な流量信号を設定する第２のガス量設定器と、前記第１ガス量設定器と第２ガス量設定器により設定された流量信号を比較して大きい方の流量信号を選択する高信号選択器と、該高信号選択器による流量信号から運転中のアノードガス流量の流量信号を減算する第２の減算器と、該第２減算器による減算結果を零に近ずけるようにアノードガス流量を制御するガス量制御器と、を備えることを特徴とする燃料電池起動時の流量制御装置が提供される。

【００１０】本発明の好ましい実施例によれば、前記ガス量制御器は、アノードガスラインに設けられた流量調節弁と、該流量調節弁を制御する調節器とからなる。
又、前記第１ガス量設定器は、アノードガス流量が所定の下限以下にならないように流量信号を設定する下限設定器を更に備える。更に、前記第１ガス量設定器及びガス量制御器は、比例制御及び積分制御を行うＰＩ制御器である。又、前記第２ガス量設定器は、負荷指令に基づき所定の関数により必要な流量信号を設定する関数制御器であるのがよい。

【００１１】

【作用】従来の起動手段で、起動時に定格出力に達していないにもかかわらず燃料利用率が高くなり過ぎる原因は、燃料電池の温度が低いため燃料電池の電圧が低く、所定の電池出力を得ようとすると、電圧が低いぶん大きい電流を取り出す必要があり（出力＝電圧×電流）、結果として上記アノード反応を右に進めることになり、大量の水素を消耗し、燃料利用率が高くなるためであることがわかった。

【００１２】本発明は、かかる新規の知見に基づき、燃料利用率が高くなり過ぎる場合には、アノードガス流量を増やすことによって、アノード反応を抑制することなく燃料利用率を下げるものである。すなわち、本発明によれば、燃料電池の起動時に、アノードガス流量、アノードガス組成、及び燃料電池の電流を計測し、前記アノードガス流量、アノードガス組成、及び燃料電池の電流から燃料利用率を算出し、前記燃料利用率が所定の最大燃料利用率より高い場合に、アノードガス流量を増やして前記燃料利用率を最大燃料利用率まで下げることによって、燃料電池にアノードガスを大量に供給して電圧が低いぶん大きい電流を取り出すことを可能にし、電池出力を高め、併せて燃料利用率を下げることができる。更に、かかる本発明の方法によればアノード反応が燃料利用率を下げずに積極的に行われ、その結果アノード反応により反応熱が多量に発生し、この反応熱により燃料電池を短時間に運転温度まで昇温することができる。

【００１３】

【実施例】以下本発明の好ましい実施例を図面を参照して説明する。図１は、従来の流量制御方法による燃料電池の起動特性を示す図である。この図において、横軸ｔは起動後の経過時間（Ｈｒ）であり、縦軸のＴは燃料電池の温度（℃）、Ｖは燃料電池（単セル）の電圧（ｍｍＶ）、Ｕｆは燃料利用率（％）を示している。

【００１４】この図から明らかなように、起動時には燃料電池の温度Ｔが低く、例えば起動後４時間で約６００℃であり、起動後約８時間で計画温度の約７００℃に達している。また、起動時には燃料電池の電圧Ｖも低く、やはり起動後約８時間経過して一定の値（約８３０ｍＶ）に達している。起動時に電圧が低いのは、温度が低いためである。従って、この段階で所定の電池出力を得ようとすると、電圧が低いぶん大きい電流を取り出す必要があり（出力＝電圧×電流）、結果として前述したアノード反応を右に進めることになり、大量の水素を消耗し、燃料利用率が高くなる。図１において起動時の燃料利用率Ｕｆが高く、特に初期には８０％以上になるのは、かかる原因によるものと考えられる。

【００１５】図２は、かかる新規の知見に基づく本発明の燃料電池起動時の流量制御装置を示す全体構成図である。図２において、本発明の燃料電池起動時の流量制御装置は、最大燃料利用率１０から運転中の燃料利用率１１を減算する第１の減算器２０と、この第１減算器２０による減算結果が負の場合にそれを正にするための流量信号１２を設定する第１のガス量設定器２１と、負荷指令１３に基づき必要な流量信号１４を設定する第２のガス量設定器２２と、第１ガス量設定器２１と第２ガス量設定器２２により設定された流量信号１２、１４を比較して大きい方の流量信号（起動時には１２）を選択する高信号選択器２３と、この高信号選択器２３による流量信号１５から運転中のアノードガス流量の流量信号１６を減算する第２の減算器２４と、この第２減算器２４による減算結果を零に近ずけるようにアノードガス流量を制御するガス量制御器２５とを備える。最大燃料利用率

１０は、最大利用率設定器２６により設定される。また、負荷指令１３は燃料電池発電装置全体の制御装置（図示せず）により別途設定される。なお、上述した各制御機器間の信号は電気信号である。

【００１６】ガス量制御器２５は、アノードガスライン１７に設けられた流量調節弁２７と、この流量調節弁２７を制御する調節器２８とからなる。この流量調節弁２７は、空圧制御弁であるのが好ましい。これにより、大流量の流量調節弁２７を容易に制御することができる。第１ガス量設定器２１は、設定される流量信号１２が所定の下限以下にならないように下限設定器２１ａを更に備える。この下限設定器２１ａは高信号選択器２３による流量信号１５をバイアス設定器２１ｂを介してフィードバックし、流量信号１５よりわずかに低い流量信号１２の下限を設定する。これにより、アノードガス流量が低くなりすぎ、燃料利用率が異常に高くなるのを防ぐことができる。

【００１７】第１ガス量設定器２１及びガス量制御器２５は、比例制御（Ｐ動作）及び積分制御（Ｉ動作）を行うＰＩ制御器であるのがよい。これにより、偏差がある限り操作量を変化させ、偏差がなくなったところで安定し、制御量を常に目標近くに維持することができる。第２ガス量設定器２２は、負荷指令に基づき所定の関数（Ｆ(X)）により必要な流量信号を設定する関数制御器であるのがよい。これにより、燃料電池特有の関数を予めＦ(X) として設定することにより、必要な流量信号１４を正確に設定することができる。

【００１８】本発明の燃料電池起動時の流量制御方法によれば、上記構成の制御装置は、以下のように作動する。先ず、燃料電池の起動時のアノードガス流量、アノードガス組成、及び燃料電池の電流を計測する。かかる計測は、従来周知の流量計、濃度計、電流計を用いて計測することができる。次いで、計測されたアノードガス流量、アノードガス組成、及び燃料電池の電流から運転中の燃料利用率１１を算出し、この燃料利用率１１が所定の最大燃料利用率１０より高い場合に、第１減算器２０により最大燃料利用率１０から運転中の燃料利用率１１を減算し、この減算結果（起動時には負になる）を正にするための流量信号１２を第１ガス量設定器２１により設定し、第２ガス量設定器２２により負荷指令１３に基づき必要な流量信号１４を設定し、高信号選択器２３により流量信号１２、１４を比較して大きい方の流量信号（１２）を選択し、第２の減算器２４により高信号選択器２３による流量信号１５から運転中のアノードガス流量の流量信号１６を減算し、ガス量制御器２５により第２減算器２４による減算結果を零に近ずけるようにアノードガス流量を制御することによって、アノードガスライン１７を流れる実際のアノードガス流量を増やして燃料利用率１１を最大燃料利用率１０まで下げる。これにより、燃料電池にアノードガスを大量に供給して電圧が低いぶん大きい電流を取り出すことが可能になり、結果として電池出力を高め、併せて燃料利用率を下げることができる。又、アノード反応が燃料利用率を下げずに積極的に行われる結果、アノード反応により反応熱が多量に発生し、この反応熱により燃料電池を短時間に所定の運転温度まで昇温することができる。

【００１９】

【発明の効果】従って、本発明の方法及び装置によれば、燃料電池の起動時に燃料利用率を高めることなく所定の負荷運転を行うことができ、かつ短時間に起動し発電することができ、併せて起動後短時間に運転温度まで燃料電池を昇温することができる。

【図面の簡単な説明】

【図１】従来の流量制御方法による燃料電池の起動特性を示す図である。

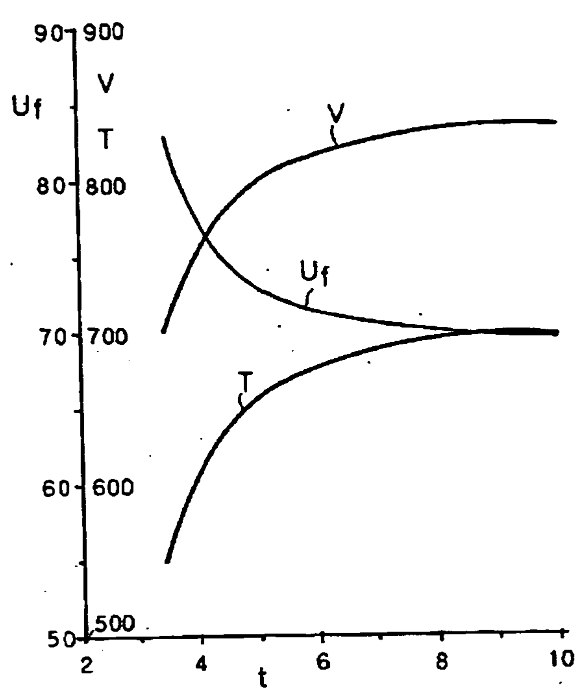
【図２】本発明の燃料電池起動時の流量制御装置を示す全体構成図である。

【図３】従来の燃料電池起動時の流量制御装置の構成図である。

【符号の説明】

１　負荷指令
２　流量信号
３　ガス量設定器
４　流量信号
５　減算器
６　ガス量制御器
７　改質器
８　燃料電池
９　流量調節弁
１０　最大燃料利用率
１１　運転中の燃料利用率
１２　流量信号
１３　負荷指令
１４、１５　流量信号
１６　運転中のアノードガス流量の流量信号
１７　アノードガスライン
２０　第１減算器
２１　第１ガス量設定器
２１ａ　下限設定器
２１ｂ　バイアス設定器
２２　第２ガス量設定器
２３　高信号選択器
２４　第２減算器
２５　ガス量制御器
２６　最大利用率設定器
２７　流量調節弁
２８　調節器

【図1】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900
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80
800
70
700
60
600
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500
2
4
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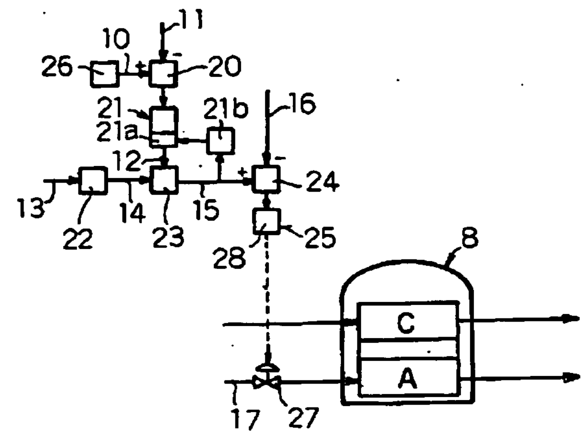
【図2】


11
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26
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21b
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21a
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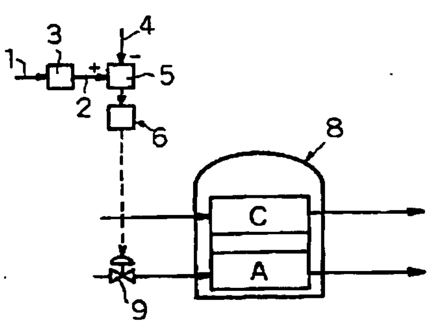
【図3】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